ANNUAL REPORT

OF THE

MINISTER OF MINES

FOR THE

YEAR ENDED 31ST DECEMBER

1925

BEING AN ACCOUNT OF

MINING OPERATIONS FOR GOLD, COAL, ETC.

IN THE

PROVINCE OF BRITISH COLUMBIA.

PRINTED BY
AUTHORITY OF THE LEGISLATIVE ASSEMBLY.

VICTORIA, B.C.:
Printed by CHARLES F. BANFIELD, Printer to the King's Most Excellent Majesty.
1926.

TRAIL CREEK MINING DIVISION.

ROSSLAND.

Operations at the mines of the Consolidated Mining and Smelting Company were greatly curtailed during the year and, according to reports from headquarters, the large amount of diamond-drilling done on outlying claims did not meet with very encouraging results; while underground, stoping operations are reported to be practically negligible and a large amount of underground equipment is being salvaged. At the present time development consists of the expansion of drifts into new territory south and west of the present workings.

Conditions do not appear to be very encouraging at present, but the company can be depended on to exhaust all possibilities before abandoning their search for new ore-bodies. The average number of men employed is about 110.

Velvet. This mine is owned by the Rossland-Velvet Mines, Limited, of which E. Nordman is president and A. W. Gregory secretary. The company is composed largely of experienced mining men, who acquired the property a few years ago. The mine is situated on the Rossland–Cascade highway at a distance of 11 miles west of Rossland.

The ore carries values in gold, silver, and copper, running up to about $40 a ton. A considerable amount of development was first done in the nineties and the mine has a fairly substantial production to its credit. Formerly it was greatly handicapped by its distance from transportation and the cost of steam-power for mining and milling requirements. Now, however, the new road has greatly obviated the transportation difficulties, while electric power is obtainable from Rossland. Another important feature in the economic operation of the property is the free drainage of the workings now afforded by the long crosscut, just completed, which gains a depth of about 250 feet below the sixth or lowest level. This tunnel is 1,730 feet long and the fifth and sixth levels, which were previously under water, are now dry. A recent report received from the company states that repairs have been made to the shaft and gallows frame and breaking ore on the third and fourth levels was started during the latter part of the year. A description of the property may be seen in Memoir 77 of the Geological Survey, Canada, by C. W. Drysdale.

I.X.L. This property, situated within a short distance of Rossland, has been worked by leasers during the last five years. It is famous for the exceptionally high-grade gold ore it has produced; in fact, it has yielded some of the most spectacular specimens of gold quartz of any property in the Province. The total value of the ore shipped by the leasers is not known at the time of writing, but it amounts to many thousands of dollars and handsome profits have been reaped.

Unfortunately badly faulted ground was encountered at depth and the downward continuation of the vein was lost some 50 feet below the No. 3 level. During the year work was necessarily of an exploratory nature and no effort is being spared to exhaust the possibilities of discovering the continuation of the vein beyond the faulted zones.

On the No. 1 level crosscutting and diamond-drill by hand have so far failed to reveal its continuation. On the third level a 200-foot crosscut was driven to develop a quartz vein cut by a diamond-drill hole; this, however, only turned out to be a broken section of vein, not much longer than the width of the tunnel. Further work was being done on this level in hopes of picking up the vein farther in the hill.

At the *Midnight* and *O.K.*, which adjoin the *I.X.L.* on the easterly and westerly sides respectively, a considerable amount of exploratory work has been done to pick up the extension of the *I.X.L.* vein. These two properties are using air from an electric-driven compressor installed at the *Midnight*.

Work at the near-by properties—namely, the *Gold King* and *Golden Drip*—has been continued during the season. The above properties are referred to in previous reports.

John Tomich put in a season at the *Cariboo* and Malcolm McIvor is reported to have been working on his claims at Murphy creek.

TRAIL REDUCTION-WORKS.

This plant, owned and operated by the Consolidated Mining and Smelting Company of Canada, is situated on the Columbia river, adjacent to the town of Trail. Immediately around the works and in the precincts of the company's property are a number of dwellings occupied by

company officials and employees, forming the municipality of Tadanac, which is the name of the railway-station at the plant and also that of the registered trade-mark of the company.

At this great plant all the gold, silver-lead-zinc, and copper ores of this district, as well as the ores from the Boundary district and a considerable tonnage from outside points, are smelted and refined.

During the years following the successful development of the *Sullivan* mine it has undergone extensive alterations and additions, until now it ranks high among the greatest metallurgical plants of the world.

Historical.—Initial construction was started in 1895 by the British Columbia Smelting and Refining Company, controlled by F. Augustus Heinze, of Butte. A narrow-gauge railway then served as a connection with the Rossland mines, at that time the chief source of supply, for then it was only a copper-smelter; the first lead-furnace not being blown in until 1899. At about this time the Canadian Pacific Railway Company bought out the Heinze interest, "lock, stock, and barrel," and the Canadian Smelting Works was formed to operate the plant. In 1906 the Consolidated Mining and Smelting Company of Canada was incorporated and took over the interests of the latter company. Since this time efficient and competent management has marked the career of the enterprise, both in the practice of mining and metallurgy; this statement is made without any reflection on the earlier operations.

The urgent demand for zinc by Great Britain and her allies during the Great War was largely responsible for energetic and aggressive action on the part of the company to produce this metal, and with this object in view the erection of an electrolytic zinc-refinery was commenced and rushed to completion in 1915 and put into operation in February, 1916.

This marked the beginning of a new era for the company, which then, naturally, had not only to turn its attention to solving the problem of recovering the values in the complex ores of the now world-famous *Sullivan* mine, but also had to face the many problems in connection with the various phases of the electrolytic refinement of zinc, which was at this time in the experimental stage.

Results were accomplished in 1916 which allowed regular shipments of zinc ore from the *Sullivan*, but it was not until four years after that the problem of concentration was satisfactorily solved by the application of oil-flotation methods; since this time the production of silver, lead, and zinc has rapidly increased.

The plant covers an area of 250 acres and includes a lead-smelting plant, a copper-smelting plant, an electrolytic zinc plant, electrolytic lead and copper refineries, a gold and silver refinery, a hydrofluoric and hydrofluosilic acid plant, a bluestone plant, a sulphuric-acid plant, and a copper rod-mill. To add to its completeness and in order to make it as self-contained as possible numerous improvements have been made in the way of accessory equipment, among the most important of which is a modern machine-shop and foundry, in which are manufactured nearly all the mechanical appliances used in the process of concentration and reduction of the various metals.

The large concentrator formerly used for the *Sullivan* and Rossland ores has been partially converted for the treatment of customs ores, which are now being received for treatment in increasing quantities.

The personnel of the chief officials of the technical staff at Trail is as follows: S. G. Blaylock, general manager; T. W. Bingay, comptroller; W. M. Archibald, mines manager; R. W. Diamond, superintendent of concentration; James Buchanan, superintendent of the smelter; B. A. Stimmel, superintendent of zinc plant; J. J. Fingland, superintendent of refineries; G. F. Chapman, mechanical superintendent; E. M. Stiles, chief engineer; F. E. Lee, chief of research.

The following general description of the plant is only intended to convey an idea of its salient features, dealing more particularly with the lead plant, but avoiding details as much as possible.

Production.—The estimated tonnage treated in 1925 is as follows: From company mines, 340,710 tons; from customs shippers, 39,570 tons; total, 380,280 tons.

Estimated production for 1925 is as follows: Gold, 21,352 oz.; silver, 4,397,455 oz.; copper, 950 tons; lead, 117,504 tons; zinc, 48,611 tons. The value of this production is placed at $29,973,453, as compared with $16,882,129 of last year.

Lead Plant.

The ores treated in this plant are to a very large extent derived from the numerous properties in this district, supplemented by those of the Boundary district, with occasional shipments from other parts of the Province. By far the greater bulk of ore which arrives at the smelter is in the form of silver-lead-zinc concentrates, most of which comes from the *Sullivan* mine. The *Sullivan* lead concentrates have an average analysis of: Silver, 20 oz. to the ton; lead, 66 per cent.; zinc, 6.3 per cent.; sulphur, 18.8 per cent.; silica, 1 per cent.; iron, 7.5 per cent.

The zinc residue from the leaching plant, of which a considerable tonnage is smelted per day, has the following analysis: Silver, 4.8 oz. to the ton; lead, 10.9 per cent.; zinc, 19.1 per cent.; sulphur, 3.5 per cent.; silica, 2.4 per cent.; iron, 37 per cent.; manganese, 0.6 per cent.

The ores are first delivered by railway-cars to the bins of the sampling-mill, from which the crushed material, emerging on one belt, discharges over a sampler. This sampler is said to give excellent results, being both accurate and flexible. It consists of three buckets spaced at equal intervals between two carrying-chains which move through the stream of discharged ore at right angles to the centre line of the belt-conveyor. Each bucket cuts 1/50 sample, which passes to a revolving table where the material is mixed and fed to a second sampler. The sample is then cut down on a Jones riffle to 200 lb., recrushed to 16-mesh, and a 40-lb. sample taken to the assay office. Concentrates finer than ¼-mesh are sampled by the fifth-shovel method, except when received in bottom dump-cars; sampling is effected by drilling auger-holes through the concentrates at regular intervals. All concentrates go direct to the Dwight-Lloyd bins.

After being mixed with the necessary flux the charge is sintered at the primary and secondary Dwight-Lloyd sintering-machines. It is then conveyed to the furnace storage-bins, weighed, and transported to the lead blast-furnaces. The fumes from the sintering-machines pass through a Cottrell treater on their way to the stack. The passage of the ore through the plant may be seen on the accompanying flow-sheet. The following data, taken from the paper presented by J. Buchanan and G. E. Murray at the meeting of the Canadian Institute of Mining and Metallurgy at Trail in October, 1923, are intended to give a few of the salient features of the method in vogue at this plant.

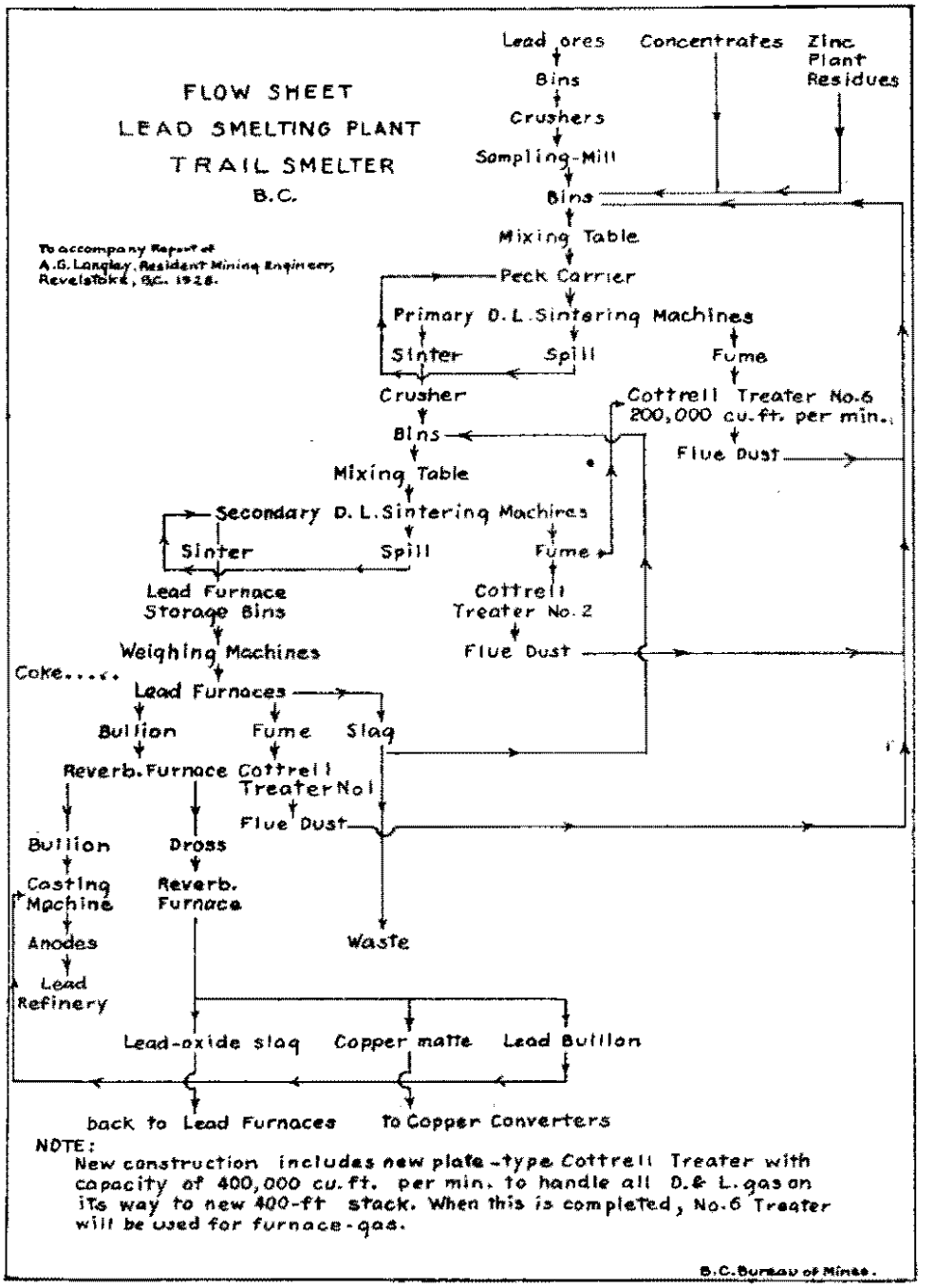
After stressing the difficulties to be contended with by the lead metallurgist, brought about by frequent changes in the grade of feed due either to methods of concentration or the character of the ores being mined, the authors deal with the methods employed which have greatly simplified matters and have been productive of satisfactory results. Emphasis is laid on the proper preparation of the charge before smelting, and in this operation the function of the Dwight-Lloyd machines is of paramount importance. The desired objective of these machines is to eliminate the sulphur in the charge. The first sintering reduces the sulphur content to 8 per cent. and the second sintering to 2 per cent. To the charge fed to the secondary machines about 13 per cent. of slag is added. The function of this slag is to mainly assist in the formation of a hard sinter; it also allows the operations to be continued when for some reason or other the primary sinter is too high in sulphur for the secondary machines. The Dwight-Lloyd machines are now being enlarged to double capacity.

As regards the blast-furnace practice, it is stated that the zinc-iron ratio is of the greatest importance in running a slag high in zinc. Given a sufficient amount of iron the whole question of smelting a charge high in zinc turns on the elimination of the sulphur, and if the charge is oxidized the furnace trouble is practically eliminated. At present the furnace-slag carries an average of 16 to 17 per cent. zinc.

Lead-smelter.—In the lead-smelter there are four blast-furnaces, the main dimensions being 180 by 50 inches at the tuyeres and 19 feet from tuyere-line to feed-floor level. The average tonnage of each is rated at 315 tons a day. The slag is granulated and conveyed to the slag-dump by launder. The fumes pass through a Cottrell treater on their way to the stack. Recent additions include a drossing plant, to which the lead bullion is conveyed by overhead electric cranes, and is first treated in a reverberatory furnace, from which the bullion is cast into anodes and the dross re-treated in a second furnace. The product of this latter is a copper matte or speiss, a lead-oxide slag, and lead bullion. The main object of this procedure is to eliminate the copper from the lead product. This plant has a rated capacity of 400 tons a day. The lead anodes, weighing about 360 lb. each, are transported in rack cars by an electric locomotive to the lead-refinery.

Lead-refinery.

This refinery has the distinction of being the first lead-refinery to use the Bett's process, which method was developed at Trail from a laboratory stage to a commercial success. The



capacity of the plant is 350 tons of refined lead a day. To give an idea of its size, the area of the lead tank-room is 84,968 square feet. The number of tanks is 956 and the power required is 2,800 kw. Briefly the process is as follows: The lead anodes are immersed in an electrolyte of 11

to 13 per cent. hydrofluosilicic acid and 6 to 9 per cent. lead. The tanks are arranged in cascades of seven, each tank having an inside dimension of 8.5 by 2.5 by 3.58 feet and holds 24 anodes and 25 cathodes. The voltage drop between the electrodes is from 0.23 to 0.5 volts; the average current density is 14.5 amperes a square foot of cathode area. The refined lead, which is deposited on the thin lead cathode sheet, is melted and cast into pigs, the finished product being 99.99 per cent. lead. The anode slimes, containing gold, silver, and impurities, go to the silver-refinery and the anode scrap is melted and recast. About 6 per cent. of the bullion is returned in the form of lead and bullion drosses to the smelter and about 3 per cent. recovered from slimes sent to the silver-refinery.

The major operations of the tank-room are done under contract, payment being for each series of operations and at its own specific rate. The tank-testers, cathode-bar cleaners, tank-cleaners, kettle-firemen, and slime-washers are all on day's pay.

Copper-refinery.

The rated capacity of this plant is 60 tons a day. The copper tank-room has an area of 24,650 square feet and that of the melting plant of 4,500 square feet. The number of tanks is 426 and the power required is 400 kw. The usual electrolytic refining practice is in use. The copper anodes from the refining-furnace at the copper-smelter are suspended in an electrolyte of sulphuric acid and copper sulphate. The cathodes are melted into ingots for shipment, the anode scrap goes back to the converters, the slime to the silver-refinery, and the impure electrolyte to the bluestone plant. In connection with the copper-refinery there is a 50-ton copper rod-mill.

Silver-refinery.

The production of Doré metal from the lead and copper tank-room slimes is effected in small magnesite-lined reverberatory furnaces, by which means the base metals, lead, copper, antimony, and bismuth, are eliminated by oxidation. The finished Doré metal is from 950 to 970 fine and contains 1.5 to 2.5 per cent. copper.

The parting is effected by the ordinary sulphuric-acid process. The gold sludges are removed to the gold clean-up kettle and treated with hot sulphuric acid till free from silver, washed sweet with water, dried, and melted for shipment. The clear silver solution is siphoned into precipitation-tanks, where, after dilution, the silver is precipitated on copper plates. This cement-silver is washed, dried, and melted into market-bars. The copper-sulphate solutions go to the bluestone plant, where they are evaporated to crystallization point.

The principal by-product of this refinery is antimony, which is recovered from the process of oxidation of the original melt and collected in settling-chambers in the form of oxide. Antimonial lead is also made from the retreatment of the slag from the original melt.

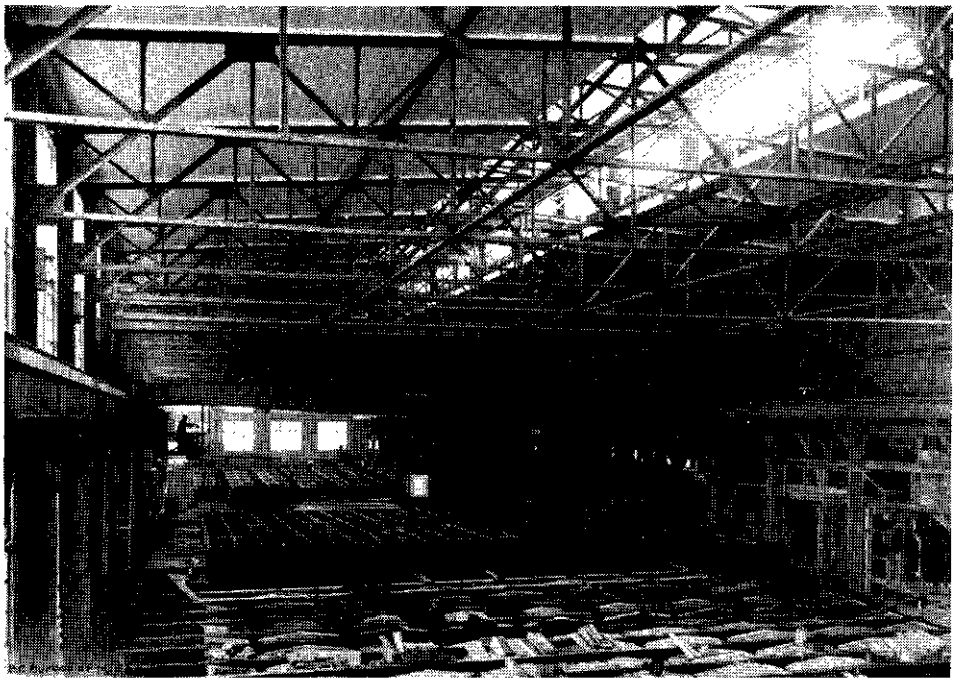
Electrolytic Zinc Plant.

At this plant all the zinc concentrates from the *Sullivan* concentrator at Kimberley are received for treatment, as well as customs zinc ores and concentrates, the latter being treated in a separate unit. The *Sullivan* zinc concentrates contain the following average values: Silver, 2.2 oz. to the ton; lead, 5.3 per cent.; zinc, 43.5 per cent.; sulphur, 33.2 per cent.; silica, 1 per cent.; iron, 19 per cent.; manganese, 0.4 per cent.

Roasting Plant.—The concentrates are fed to seventeen Wedge mechanical roasters of the seven-deck type, their function being to oxidize the zinc sulphide so as to render it soluble in dilute sulphuric acid. An interesting and very important feature in connection with the *Sullivan* ore is that the zinc occurs as marmatite, the isomorphous iron of which readily combines to form zinc ferrate, which is insoluble in dilute cold sulphuric acid, and hence, not being affected by the leaching process, forms a large proportion of the residue, which has to be smelted for the recovery of silver and lead. Sulphatizing the roast is avoided as much as possible, for this would create an excess of sulphuric acid in the leaching solutions.

The fumes from the roasters pass through a new flue, built in 1925. This flue is 420 feet long by 28.8 feet wide and 18 feet high (inside measurements) and is 10 feet above the level of the ground. The entire area of the bottom of the flue consists of hoppers, 475 in all.

Cottrell Treater.—After passing through this flue the fumes enter a Cottrell treater, also erected during 1925. This contains three flues through which the fumes pass. The equipment is contained in a building 104½ feet long by 78½ feet wide and 67½ feet in height, constructed of reinforced gunnite supported by steel framework.



Consolidated Mining and Smelting Co. of Canada—Lead-refinery at Trail.

Consolidated Mining and Smelting Co. of Canada Zinc Tank-room at Trail.

Each treater-flue, which is 15 feet in width, 12 feet in height, and 104 feet in length (inside measurements), is built for six sets of precipitating-plates, but only four sets of plates are required for the present operation. Each set of plates is made up of sixteen plates (10 by 12 feet) placed 12 inches apart, and made of corrugated Keystone steel (0.2 per cent. copper steel). The sets are hung in the flue with the plates parallel with the direction of the flow of gas. In the centre between the plates and running full length of the space between the plates are hung high-tension wires (5 inches apart) which are kept taut by lead weights.

Each set of plates is supported on the framework of the building on each of its four upper corners and under each support is placed a large spring. This spring allows the set of plates to vibrate when the supports are struck with a hammer. The vibration jars the precipitated dust loose from the plates and it falls into the hoppers below, of which the entire bottoms of the flues consist, there being 162 hoppers in all.

The high-tension wires are hung from a framework which is supported on four porcelain insulators placed on the outside of the flue. A light blow on the centre of the framework jars the dust loose from the wires. The voltage required for this treater is 60,000 volts.

Stack.—The gas passes from the treater into the base of a reinforced-concrete stack 409 feet in height and 21 feet inside diameter at the top. This stack is lined with a 4-inch wall of hard-burned brick its entire length. A 2-inch air-space is left between the brick wall and the concrete. A similar stack is now being erected for the lead-plant fumes.

Leaching-plant.—The hot calcine from the roasting plant is conveyed to the leaching plant by special spiral-screw pipe conveyors (evolved by the staff), where it enters the leaching solution. In the leaching method used at Trail there are two distinct circuits, the "acid" and the "neutral." All the hot calcine enters the "neutral" circuit and by making it alkaline has the effect of precipitating the ferric iron along with antimony, arsenic, and other impurities. The solids from the "neutral" circuit pass through the "acid" circuit, where they are treated with returned acid electrolyte, which is regulated to ½ to 1 per cent. of sulphuric acid to ensure the dissolving of all the soluble zinc. The zinc residue from the "acid" circuit, after washing and filtering, is stacked in great piles outside the plant and is finally smelted at the lead blast-furnaces. Its analysis is given as follows. Silver, 4.8 oz. to the ton; lead, 10.9 per cent.; zinc, 19.1 per cent.; silica, 2.4 per cent.; iron, 37 per cent.; manganese, 0.6 per cent.

The effluent solution from the "neutral" circuit, after being treated by zinc-dust to precipitate the copper and cadmium and clarified by filtering, is ready for electrolysis.

Electrolytic Plating Department.—The electrolyte, containing about 8 per cent. sulphuric acid, flows through a number of cells, each cell being 27 by 80 by 42 inches (inside dimensions) and containing 17 lead anodes and 16 aluminium cathodes. The cathodes are 24 by 36 by 0.1 inches and are spaced 4 inches centre to centre. The current density is from 26 to 27 amperes per square foot and the voltage drop is about 3.5 volts.

The plating of the zinc is done in three large buildings, as follows: No. 1 building contains 14 units of 36 cells each (504 cells); No. 2 building contains 12 units of 36 cells each (432 cells); No. 3 building contains 5 units of 144 cells each (720 cells).

No. 1 and No. 2 buildings are equipped with motor generator sets, each set consisting of one motor and two generators. The motors are 2,200-volt synchronous motors, requiring 1,150 k.v.a. at full load. The generators are 500-kw. machines producing 4,000 amperes at 125 volts. One generator produces the current required by one unit of 36 cells.

No. 3 building is equipped with five synchronous converters. Each converter produces power required for one unit of 144 cells, which is 4,500 amperes at 550 volts (2,500 kw.). Each converter has its own transformer, the power being transformed in one step from 60,000 volts to 380 volts, which is the voltage required for the converter. The direct-current voltage required for a unit of 144 cells is about 510 volts and the converters are constructed with a booster which gives a boost or a buck of 40 volts, thus giving a range of from 470 to 550 volts.

The converter-room and generator-rooms are supplied with cool washed air, each building having its own air-washing plant.

The No. 3 building and its electric equipment were completed during 1925.

The power requirement for the zinc plant is 28,000 kw. and for other parts of the Trail plant is 11,000 kw., making a total of 39,000 kw. or 52,200 horse-power. This power is developed at Bonnington Falls by the West Kootenay Power and Light Company, a subsidiary company of the Consolidated Mining and Smelting Company.

Melting and Casting.—The zinc sheets, which are stripped from the aluminium cathodes, are weighed, stacked on small trucks, and taken to the melting-room. Here they are melted in reverberatory furnaces, from which the molten zinc is dipped by a large ladle and cast into bars. The product from the plant is 99.956 per cent. zinc. The rated capacity of the zinc plant is about 200 tons a day.

Copper-smelter.

The principal sources of supply for this plant are the company's mines at Rossland and the Allenby Copper Company's property at Allenby. Only a small tonnage is being won from the Rossland properties at the present time and this arrives at the smelter as crude ore, while the product of the Allenby Copper Company arrives in the form of flotation concentrates, which necessarily require sintering before treatment in the blast-furnaces.

Briefly, the plant consists of three copper blast-furnaces, two 54- by 420-inch and one 42- by 210-inch; two converters of the Great Falls type 12 feet in diameter; a reverberatory refining-furnace and anode casting-machine. The sampling-mill in connection with this plant is equipped with Vezin samplers and gyratory crushers, while Dwight-Lloyd sintering-machines are available for the treatment of copper concentrates.

Co-operation with the workmen is aimed at by the company, which in 1923 inaugurated a scheme by which workmen's co-operative committees were formed for the purpose of investigating all labour troubles and making recommendations to the management. This has proved to be a great success in helping to adjust all matters pertaining to the welfare of the employees.

A system of bonuses based on group cost and increasing recoveries and on the price of lead and zinc was also established. By this system the workmen reap a benefit according to the operating efficiency of the plant. The total number of men employed at the plant is 2,100.

The data contained in the above brief description of the Trail plant have largely been obtained from papers presented by the staff at the meeting of the Canadian Institute of Mining and Metallurgy held at Trail in October, 1923, and from information freely supplied by S. G. Blaylock and chief officials of the company.

For further information refer to: Transactions of the Canadian Institute of Mining and Metallurgy, Vol. XXVII., 1924. Chem. & Met. Eng., August 11th, 1920. Engineering and Mining-Journal Press, July 28th, 1923.

LIST OF SHIPPING-MINES IN THE TRAIL CREEK AND LARDEAU MINING DIVISIONS, 1925.

Mine.	Locality.	Tons.	Character of Ore.
Golden Drip	Rossland	5	Gold, silver, copper.
I.X.L.	Rossland	87	Gold, silver.
Consolidated Co.'s properties	Rossland	37,504	Gold, copper, silver.
Dunvegan	Lardeau	7	Silver, lead.
Total		37,603	

REVELSTOKE, LARDEAU, AND TROUT LAKE MINING DIVISIONS.

The season has witnessed a decided revival in the interest taken, particularly by outside capital, in the potentialities of this northern section of the district, as manifested by the numerous examinations made by visiting engineers representing large interests. Few known properties of merit escaped examination and a repetition of these conditions may be expected next season.

The work undertaken during the year at numerous properties was of an exploratory nature, very little ore being mined for shipment, but it is anticipated that before long new names will be added to the rapidly swelling list of shippers of District No. 5.

REVELSTOKE MINING DIVISION.

J. & L. Group. This property was acquired under option by the Porcupine Goldfields Development and Finance Company. Extensive tests are now being made on the ore with a view to solving its economic treatment; it is a complex mixture of iron, lead, and zinc sulphides carrying values in gold, silver, lead, and zinc, with which is